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China Report

SCIENCE AND TECHNOLOGY

No. 151

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CHINA REPORT

SCIENCE AND TECHNOLOGY

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OPERATIONS RESEARCH, SYSTEMS ANALYSIS DEVELOPMENT DISCUSSED

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[Article by Song Chun [2646 2504] and Ji Fa [1015 4099]: "The Development of Operations Research and Systems Analysis in Our Nation"]

[Excerpts] Since World War II, operations research and systems analysis (abbreviated OR/SA) have gradually formed and developed as a new comprehensive science, and they have won popular attention among the world's governments and peoples. Especially in some industrially developed nations, operations research and systems analysis are widely used to carry out all kinds of complex tasks, from establishing national policies to performing tasks in government offices, businesses, schools and the military, and they have achieved results. In recent years, some developing countries have also begun to study and apply this scientific discipline with remarkable results in their efforts to hasten the rate of national economic development.

This article presents some general views about the history of this science and its future development in our nation.

I. Our Nation's Ancient OR/SA

China is an ancient nation with a civilization of several thousand years. Origins of simple OR/SA ideas can also be found in the rich treasurechest of history. In the sixth century B.C., our nation's famous militarist Sun Wu had already utilized such ideas in his "Art of War by Sun Zi." For example, in the "Chapter on Strategy," he said that in war, our side and the enemy should be comprehensively compared in the five aspects of politics, opportunities, favorable geographical position, commanding generals and discipline to analyze the situation to see who would win and who would lose. This coincides with the elements of wholeness and systematism in OR/SA. The importance of quantitative analysis to military victories and defeats mentioned in the "Chapter on Formation" and many similar OR/SA ideas can also be found in his writings. During the Period of the Warring States, there was a story about Qi Wang and his minister Tian Ji racing horses.* Actually, this was also an early idea of game theory.

The ideas of operations research analysis were also used in early times for forecasting. For example, in the "Art of War by Sun Zi" mentioned above, the "Chapter on Offensive Planning" and the "Chapter on Strategy" both explained the great significance of forecasting the outcome of war. In the "Book of Changes" and in books on natural studies by Taoists, weather forecasting occupied many pages. Utilizing daily phenomena in short-term eographical and meteorological forecasts was even more common. For example, history recorded the method of forecasting rain by "observing wet plinth for rain" and forecasting earthquakes by observing the unusual phenomena of "gathering of barking dogs," the "fears of nested birds" and the emergence of large numbers of rodents and snakes from their holes.

Historical records also revealed that some astrologists sought objective patterns of long-term cyclic forecasts in large amounts of statistical computations, such as the establishment of the calendar, forecasting the solar eclipse, the lunar eclipse and estimating harvests of coming years. After the Sung dynasty, the imperial court also established such specialized official duties as the official meteorologist. These were all cases of early ideas of operations research analysis and forecasting in our nation. But because production was backward at the time, they could only be spontaneously applied in a scattered way and they could not be developed into a systematic applied science.

II. A Brief Historical Review of OR/SA in New China

After the rounding of New China, the development of operations research and systems analysis can roughly be divided into the following stages of development:

1. The Beginning Stage of Development (Mid-1950's to Mid-1960's)

Organized study of operations research and systems analysis as a branch of modern science began in 1956 in our nation. At the time, our nation's first operations research group was founded under the direction of Comrade Qian Xuesen [6929 1331 2773], director of the Mechanics Institute of the Chinese Academy of Sciences, and some books on OR/SA were translated and published. Some industrial departments began exploring the application of operations research analysis in engineering techniques.

In 1958, the Mathematics Institute of the Academy of Sciences established on Operations Research Laboratory. Because of the need for developing production, some provincial and municipal industrial and mining enterprises and higher educational institutions of the time, including those in Beijing and Shanghai, began studying and applying operations research. Some schools also established operations research staffs. Linear planning was applied the most, mainly in transportation, rational input of materials and arrangement of the labor force. Other topics,

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*In the story, Qi Wang and Tian Ji each selected a good horse, a medium horse and a poor horse. They agreed that whoever lost one horse would have to pay 1,000 pieces of gold, and whoever won one horse would receive 1,000 pieces of gold. Since Qi Wang's horses were all slightly stronger than Tian Ji's horses when compared on the same basis, if the horses of similar strength were played one by one, Tian Ji would surely lose. Thus, Tian Ji used his poor horse to oppose Qi Wang's good horse, his good horse to oppose Qi Wang's medium horse, and his medium horse to oppose Qi Wang's poor horse. As a result, Tian Ji won two rounds and lost one, winning the thousand pieces of gold.

such as queueing theory and quality control, were also applied by the postal and telecommunications and textile departments, but most of the projects were not structurally complex. In 1960 and 1962, national operations research conferences were held twice, and from then on the study of operations research gradually became established.

2. The Stage of Popularizing the 'Dual Method' (Mid-1960's to the Beginning of the 1970's)

About 1965, Professor Hua Luogeng [5478 5012 1649], director of the Mathematics Institute, began to popularize "PERT-CPM." At the time, this was used most in organizing construction work and in establishing plans for equipment inspection and repair. Later, it was gradually popularized in other professions. In 1970, Comrade Hua Luogeng also popularized "optimization." He used nontechnical language and simple methods for widespread propaganda and practice among workers and he achieved fairly good results. Later, he abbreviated this method as the "dual method," and he continued to popularize its application in many provinces and cities throughout the nation.

3. Developmental Stage

At present, our nation's people have again entered a new period of history, that of progressing toward the four modernizations. To push the entire national economy toward high-speed proportional development according to plan, we must not only summarize our nation's own experience in national construction, but we must also digest the beneficial experience of other, advanced nations. Science and technology, the development and utilization of resources, organization and arrangement of the labor force all urgently need a whole set of analytical and managerial methods for scientific planning. We are confronted with a huge systematic and complex socioeconomic systems engineering task. A large number of scientists, mathematicians, educators, economists and social scientists are beginning to learn and explore the theory of OR/SA and its broad application in their respective fields. Not long ago, Comrade Qian Xuesen and others published an article entitled "The Techniques of Organization and Management--Systems Engineering" in the Shanghai WEN HUI BAO. The article systematically explained his new viewpoints. At present, some departments and schools have already established staffs and research agencies to begin training university students and graduate students in this field. Planning departments have also begun to use OR/SA methods on a trial basis to carry out comprehensive planning and long-term forecasts. Certain large engineering projects have also begun to use it. The nation has already officially included OR/SA in the nation's scientific and technological development plans. In the winter of 1978 an operations research staff conference was held, and nearly 100 research papers were presented. OR/SA has again entered a new stage of development.

III. [passage omitted]

IV. Prospects of the Development of OR/SR in China

1. Inviewing the natural conditions, our nation has good conditions for the application and development of OR/SA. First, our nation has expansive territory

and its resources are rich. Second, the population and the labor force are numerous. These are also the most fundamental material foundations for developing any business. Our nation covers a territory of 9.6 million square kilometers, and it is one of the most [illegible] nations in the world. China's minerals (coal, petroleum and reserves of many metals) and water resources are among the leading ranks in the world. But because the industrial foundation is weak, up to now, efficient and rational development and utilization on a large scale have not been carried out.

In the present national economic plans and planning work, engineering construction and scientific research both need the application of OR/SA theories for selection of the best plans. These are so-called "economic systems engineering," "scientific systems engineering" and "engineering systems engineering" mentioned by Comrade Qian Xuesen in the article. Our nation's population already approaches 1 billion at present, and it is growing at a rate of about 10 percent a year. During the 1980's, it is estimated that the population will surpass 1 billion. With such a huge population, regardless of whether the problem is feeding and housing or providing transportation, education and employment, it will be a very complex social problem. This is what Comrade Qian Xuesen has called the problem of "social systems engineering." Of course, to achieve greater, faster, better and more economical results in building the nation, we still need to apply OR/SA in other areas, which could be called "administrative systems engineering" etc. Our government has already proposed that modernization of management be undertaken. This is an important link in developing the national economy and hastening the realization of the four modernizations. Our nation has also established a "research committee for the modernization of management," a "technical economics research committee," a "metrological economics research committee" and a "future studies committee." Not long ago, the Chinese Academy of Sciences established a Systems Science Institute and an Applied Mathematics Institute. Other industrial, economic, educational and military departments have also established different forms of organization to apply and study systems engineering. In general, from the point of view of our nation's objective conditions, the future for development of OR/SA is very good.

2. From the viewpoint of our socialist system and guiding ideology, ours is a nation of socialist ownership guided by Marxism-Leninism-Mao Zedong Thought. Can the scientific method that has been effective in industrially developed capitalist nations work in our nation? This is a question that must be touched upon in talking about China's OR/SA. We will only present a few preliminary viewpoints.

First, OR/SA is a scientific method. It is a historical product of social progress when productivity develops to a definite stage. The scientific and technological revolution during the mid-20th century and the large-scale wars provided the possibilities for the emergence and application of this scientific method. Engels believed: "....thought is to divide the object of consciousness into many parts, the same as combining the various related parts into a unified whole. Without analysis there will not be synthesis." Lenin called the combination of analysis and synthesis an important element if dialectics. Therefore this method itself, which requires quantitative and qualitative synthesis and analysis of objective matter, conforms to the methodology of dialectical materialism in the philosophical view. But it does not equal dialectical materialism itself, because the method of dialectical materialism studies the more general methodology of philosophy, while OR/SA studies nonphilosophical, concrete "scientific methodology."

Second, the characteristics of the socialist public ownership system in economic development is planned, proportional high-speed development. In method, it is also a question of optimization on an objectively arranged foundation. The constructive guideline of "achieving more, faster, better and more economical results" proposed by Comrade Mao Zedong is very suitable for using this scientific method. U.S. national defense economist Xiqi [phonetic] believed that even if private enterprises do not carry out systems analysis, they can still improve work efficiency and competitive capability through the market's price patterns and the attraction of profits. But government and national defense agencies lack this kind of natural internal mechanism to improve efficiency. They mainly rely on the planning departments to draw up plans and budgets and other administrative methods to carry out their work. Economic feedback is weak. They cannot adjust automatically. If scientific analysis not carried out beforehand, there is a lot of blind activity and the economic loss is large. He believed this was the reason OR/SA was first applied on a large scale in the national defense departments. But in the United States, the basic conflict in the capitalist system itself determines the inability for further unification and for true and rational distribution. The socialist public ownership system is more centralized and unified than that of capitalism. There is no basic conflict of interest among the government, enterprises and individuals. Therefore, in using this scientific method, the socialist public ownership system has a higher self-awareness than capitalism and can better develop the subjective mobility of the personnel at each level. This is also a favorable factor in our forecast of the prospects for the development of OR/SA.

Third, in the viewpoint of historical materialism, Marxism-Leninism-Mao Zedong Thought are continually developing under the prerequisite that their basic theories and principles do not change. OR/SA and modern computers, as a kind of advanced method and tool, may be able to help contemporary and future social scientists more accurately predict the future and combine the actual situation of each nation to further explain the new Marxist-Leninist ideology. This is the necessary trend of mutual penetration of natural science and social science. Our nation's social science workers are following the principle that "practice is the only standard to judge truth" and are summarizing our nation's practical experience of past revolutionary struggles. OR/SA will surely catch up with the objective needs of the time and will continue to develop through its own actual application.

At present, our nation's academic thinking is more active. Scientists are all willing to explain their own views of problems using different methods and from different angles, although these methods are not yet perfect. The following is a preliminary attempt to apply some scientific methods in social science we have explored together--a diagram showing the trend of the structural relationship of organizations and management in different social systems, to serve as a reference for everyone.

The ordinates indicate the high and low positions of the leading personnel, the abscissa indicates the amount of labor and work. The curve in the figure divides work into two major categories. The left side of the curve is management. The right side of the curve is actual work. The former is mainly mental labor, the latter is mainly physical labor. It can be seen from the diagram that the proportion of physical labor and mental labor varies according to the high or low positions of the tasks. The workload of the highest level management is large. The workload of physical labor is small, while the situation of the bottommost level is the opposite. OA, OC, OD, OE, and OA'OB' on the abscissa below show the workload of the leadership participating in physical labor. This is only broadly possible in China under our socialist system in which a "three-way alliance" of leading cadres, technical personnel and the broad masses can be realized.

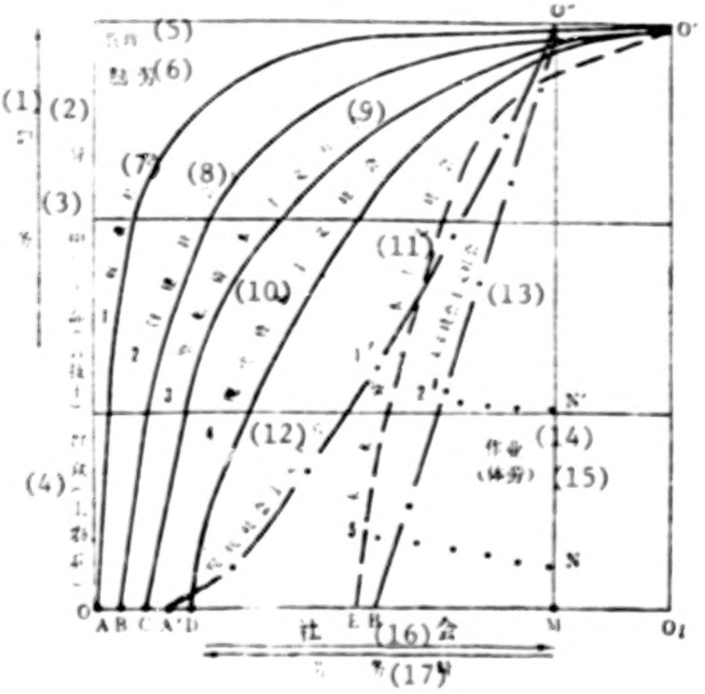


Figure 1. Diagram of the Trend of the Relationship Between Management and Labor Under Different Social Systems

Key:

(1) Duties
(2) Leadership
(3) Midlevel cadres (including technical cadres)
(4) Masses (workers, farmers, soldiers)
(5) Management
(6) (Mental labor)
(7) 1 Slave society
(8) 2 Feudalist society
(9) 3 Primitive capitalist society
(10) 4 Modern capitalist society
(11) 5 Future capitalist society
(12) 1' Modern socialist society
(13) 2' Future socialist society
(14) Labor
(15) (Physical labor)
(16) Society
(17) Amount of work

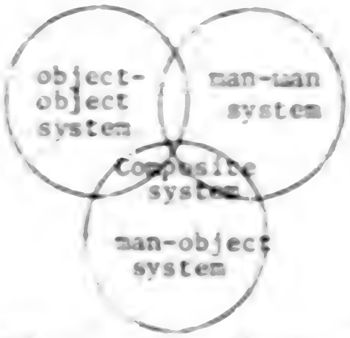
Slavery--slave society
Feudalism--feudal society
Primitive capitalism--primitive capitalism
Modern capitalism--modern capitalism
Future capitalism--future capitalism
Modern socialism--modern socialism
Future socialism--future socialism

The two families of curves in the diagram (1,2,... and 1', 2', 3',...) show the course of historical progress from left to right. As production develops, the degree of automation increases. The curves shift to the right, and as a result, the total number of work hours is shortened. The efficiency of labor is improved. Physical labor is reduced, and the proportion of mental labor is correspondingly increased. Under socialist conditions, the broad number of workers have more time to participate in management and to enjoy more material and cultural life, while capitalism, other than giving workers some benefits, will still produce economic crises and moral crises because of the insurmountable conflicts in the social system itself. Finally, these conflicts can only be solved through various forms of revolution by the proletariat. When the curves shift toward the straight line O"M and overlap the line, the society will have entered into the world of Great Harmony--the communist society will historically eliminate the "three major" differences.

3. Viewing the international development of OR/SA, we see that it has had a history of about 40 years from its inception to the present time. The development, popularization and application of OR/SA in most industrially developed nations require about 20 years. At the beginning of the 1940's, the United States and Britain began to apply operations research and systems analysis during World War II, but true popularization on a large scale in the national defense departments and later in the various sectors of the national economy occurred during the beginning and the middle periods of the 1960's. Japan and the Soviet Union began such work in the 1950's but relatively more application began in the 1970's.

Here, we have utilized relatively complete statistical data from the Japanese "OR Encyclopedia" (see Table 1 and Figure 2). It divides the systems into four categories: object-object, man-object, man-man and composite systems. This is a course from the simple to the complex. Reports published during the 1950's showed that mainly the object-object system was studied. There were only a few projects studying the man-object system. There was only one project studying the man-man system, and there were no studies of the composite system. During the 1960's, there was only one project studying the composite system. Further projects to study the composite system began only in the 1970's. This covered a course of 20 years. For example, the curve shows that the development from the object-object system to the man-man system spanned more than 10 years and the development from the man-man system to the composite system also required about 10 years. In the past, besides developing theoretical research in our nation, more applications were realized in the object-object and the man-object systems. Because our nation's whole scientific, technological and industrial foundation was weak, because of a lack of statistics and figures, because the management system was not sound enough--that is, the subsystems and technical units which serve as the foundation of systems engineering were still not completely established--therefore, during the current transient stage of development toward the man-man system and the composite system, a large amount of basic buildup in this respect is still needed. This means that it is possible that a longer time will be required than for industrially developed nations. Beginning from 1956 to the time Comrade Hua Luogeng popularized the "dual method," our nation had undergone 20 years of history. In the development of theory and application, our nation is actually still in the beginning period of development at present. This period was longer than that in industrially developed nations by 5 to 10 years. If we disregard the complex sociopolitical factors, then according to the above patterns, the next period of development will still require 10 to 15 years before the man-man and composite systems can be massively applied. But if we fully utilize our nation's favorable conditions, it will be possible to shorten this cycle.

Table 1.



System / Time	Object-object system Quantity	Man-object system Quantity	Man-man System Quantity	Composite system Quantity	Total Quantity
1950-1959	16	9	1		26
1960-1969	54	37	14	1	106
1970-1975	58	33	37	20	148
Subtotal	128	79	52	21	280

Taken from the statistical data in the Japanese "OR Encyclopedia"

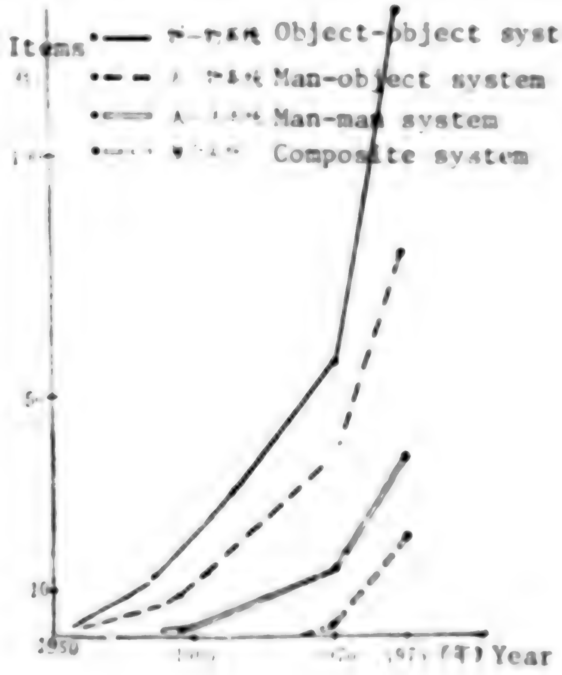


Figure 2.

Curves drawn from statistical data taken from the Japanese "OR Encyclopedia"

4. The development of operations research and systems analysis is forecast according to the rate of development of the national economy. If our national economy progresses at the average growth rate (10.9 percent) of the first 5-year plan, starting from 1980 after a short period of transition, then by 1900 the total national product will increase twofold over the present, and by the year 2000 it may increase by six to seven times or more. With our efforts, this will approach or roughly equal the current level in the United States. Then, to adapt to such a high-speed development in the national economy, OR/SA must also hasten its steps of development. Viewing the experience already obtained by some developing nations and considering our nation's especially favorable conditions, we see that if we can develop the superiority of the socialist system further, then with our efforts, it is entirely possible to develop OR/SA on a broad basis in about 10 years or slightly longer, and we can catch up with the internationally advanced levels in theory to contribute to the glorious goals of realizing the four modernizations by the end of this century!

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APPLIED SCIENCES

RESEARCH IN SUPERCONDUCTOR TECHNOLOGY REVIEWED

Beijing GUANGMING RIBAO in Chinese 9 Jan 82 p 1

[Article: "Our Nation's Scientific Research in Superconductor Technology Realizes Welcomed Progress, the National Academic Conference on Superconductor Technology Is Held in Beijing"]

[Text] Report by reporter Hu Youquan [5170 2589 3123]: The National Academic Conference on Superconductor Technology jointly held by the China Refrigeration Engineering Society, the China Physics Society and the China Metals Society was recently held in Beijing. Delegates attending the conference reviewed our nation's research in superconductor technology in recent years. They believed that welcomed progress has been realized in the application of superconductor materials, low temperature technology, magnet technology and medium and small magnets. Definite progress has also been made in experiments of superconductive electric motors and separation of superconductive magnets.

Our nation's superconductor materials can now satisfy domestic needs. This has established a firm foundation for developing our nation's superconductor technology. For example, a practical superconductive material, the multiple core niobium-titanium wire which has been successfully developed performs well. It has begun batch production and it has already been used in research in superconductor technology. The high field superconductor niobous tin strips possess our nation's technological characteristics and they have begun batch production.

In low temperature technology, our nation can provide helium gas on a relatively large scale and we can independently develop our own helium liquefaction technique (the temperature of liquid helium is -269°C). Several dozen liquid helium refrigerators have already been developed and produced. They can basically supply the domestic needs in scientific research in superconductor technology.

The technology of separating superconductive magnets is very effective for selecting certain rare and precious metals and nonmetallic minerals. Our nation has already launched some experimental work and has realized definite results.

Delegates attending the national academic conference on superconductor technology believe that at the present time, the emphasis in the development of superconductor technology in our nation should be to continue the development of medium and small superconductive magnets, the development of the technology of separating superconductive magnets, the development of research in superconductive electric motors, to continue the active development of research in superconductive quantum interferometers and devices and their application, to continue to develop scientific research in the technology of superconductor materials and technologies in a bid way, and to develop scientific research in low temperature technology and equipment.

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CSO: 4008/74

APPLIED SCIENCES

PRODUCTION OF ELECTRONIC CONSUMER GOODS IN FUJIAN INCREASED

Fuzhou FUJIAN RIBAO in Chinese 4 Jan 82 p 1

[Article by Wu Fengxiang [0702 7685 4382] and Liu Shanguo [0491 0830 0948] of the Provincial Electronics Industry Bureau: "Our Province's 'Four Major' Electronics Products Increase by a Large Scale, Comparing the Same Period in 1981 and 1980, Television Sets Increased Nearly Five Times; Radios Increased 1.1 Times; Pocket Calculators Increased 6.4 Times. Newly Produced Recorders Number Over 45,000 Units"]

[Text] The production of the "four major" consumer electronics products that have been designated as key development products in our province: television sets, radios, recorders and pocket calculators, has increased by a large scale since last year. Up to the end of November, over 138,000 television sets have been produced, an increase of nearly 5 times over the same period the year before last. Over 278,000 radios have been produced, an increase of 1.1 times over the same period the year before last. The number of pocket calculators produced totaled 294,000 units, an increase of 6.4 times over the same period the year before last. Over 45,000 tape recorders have been newly produced in 1981.

Concerned departments established a coordination group for the "four major products" at the beginning of last year. They carried out a series of measures and expanded the productive capabilities for the "four major products". The Fure Color Television Company Ltd with an annual production capacity of 300,000 sets and the Quanzhou Television Plant with an annual production capacity of 150,000 sets have already begun production. The productive capability of the Fujian Television Plant which produces 12-inch black and white television sets increased from over 3,000 sets the year before last to the present 20,000 sets. The productive capability of radio sets in the province centered around the Fuzhou Radio Plant increased from the 200,000 sets in 1980 to 500,000 sets. The 8400 Plant and the Shanghai 101 Plant have jointly built the Haiyan Brand electron tube radio production line with capacity of 50,000 units. At the same time, a process assembly production line for tape recorders with an annual capacity of 150,000 units was built using some key instruments imported from abroad coupled with equipment and devices designed and manufactured by ourselves. The productive capability of calculators of the 8460 Plant has also reached an annual capacity of over 400,000 units.

To develop product varieties, hasten renovation and replacement, concerned departments organized activities for creating new broadcasting and television products and established a creative products award. The quality of the Shanhu Brand television set has been improved. The plastic casing is now being manufactured in our own province. Small table top transistor radios suitable for farm villages in mountain regions have begun production in batches. Trial production of the all silicon trube amplitude modulated and frequency modulated radio is progressing rapidly. New progress has also beenmade in domestic production of tape recorders and pocket calculators.

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Machining Procedure in Making Mold for O Ring......Zou Desheng [6760 1795 3932], Plant 5708, Guiyang (34)

Application of Super Plastic Forming Technique......Hong Shenzhang [3163 1957 4545], Shanghai Jiaotong University (36)

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9717
CSO: 4008/99

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TITLE: "Optical Analogy of Lateral Inhibition Effect and Application in Image Processing"

SOURCE: Beijing SHENGWUHUAXUE YU SHENGWUWULI JINZHAN [BIOCHEMISTRY AND BIOPHYSICS] in Chinese No 6, Dec 81 pp 41-43, 26

ABSTRACT: The lateral inhibition effect was discovered in the eye of turtles and later found in the visual sensory system of people and animals like cats and frogs. Many mathematical models have been proposed to describe it, the simplest being the second differential model of Marr. The use of the second differential cancellation circuit to improve image quality in television circuits represents the optoelectronic analog of the lateral inhibition effect. Barlow proposed that animal perception systems possess the function of reducing redundant information. The paper points out that a special characteristic of human visual perception is the very strong reaction to changes in light intensity. A diagram showing the eye's reaction to light whose intensity change is represented by a square wave is explained. A photographic method of image enhancement developed over 40 years ago is also explained and this is also described as an analog of the lateral inhibition effect. This involves taking an unprocessed negative and in a blurred fashion transform-

[Continuation of SHENGWUHUAXUE YU SHENGWUWULI JINZHAN No 6, 1981 pp 41-43, 26]

ing it into a positive. The theory of lateral inhibition is discussed in terms of the mathematics of positive and negative film and the mathematical principles of image enhancement. The article proposes a procedure which is the optical analogy of the lateral inhibition effect in biological perception systems. A blurred positive image is produced under developing conditions where the reflectance of the negative is less than 1. When the positive and the negative images are superimposed on one another, an image is produced representing the spatial differential of the original image over the new image. The contours are strengthened so that they stand out in detail to function like the lateral inhibition effect nervous network.

AUTHOR: XIE Jinguang [6200 2516 0342]
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ORG: Shanghai Research Institute of Physiology, Chinese Academy of Sciences

TITLE: "A Practical Interface Circuit of Keyboard and Display Unit for Microcomputers"

SOURCE: Beijing SHENGWUHUAXUE YU SHENGWUWULI JINZHAN [BIOCHEMISTRY AND BIOPHYSICS] in Chinese No 6, Dec 81 pp 73-76

ABSTRACT: Under conditions of hardware scarcity, interfacing methods become a matter of great concern. For example, with the smallest CS-85 microprocessor system, due to limited memory, a scanning method could not be used. This interface was designed using the Intel chips 8085, 8755, 8155, and 8185 as the heart of the system. Major features include the following: The Intel 8085 RST 5.5 is used as the keyboard input interrupt port. The handshake method is used for data input. A single character is used as the data input unit. The hexadecimal code is used for keyboard data. Special keys and control keys generate one character of information. Ordinary keys generate half a character, i.e. the hexadecimal digits 0-F. To inhibit control errors, not more than one keystroke is allowed at a time. Several diagrams of the circuit and circuit components are provided and explained in some detail. The paper concludes that while this circuit is designed for the smallest configuration of the CS-85, with slight changes to the transmission lines

[continuation of SHENGWUHUAXUE YU SHENGWUWULI JINZHAN No 6, 1981 pp 73-76]

it could be made suitable for other microcomputer systems. The adoption of the handshake method and the hexadecimal code is to save CPU time, software requirements, and memory. When a key requests interrupt from the 8085 through the 8155, software is required to release the interrupt port.

6168
CSO: 4009/247

AUTHOR: CHANG Jiaxiang [1603 1367 4382]

ORG: None

TITLE: "Power Oil Consumption Meter"

SOURCE: Beijing YIQI YU WEILAI [INSTRUMENTATION AND FUTURE] in Chinese No 12, 81 p 20

ABSTRACT: The Shanghai Electric Meter No 2, the Locomotive and Car Research Institute of the Department of Railway Science Academy, Shanghai Transportation University, Shanghai Diesel Engine Plant, etc. have produced the PY Power Oil Consumption Instrument through joint research. It is an electronic instrument for continuous digital read out and automatic continuous measurement of engine power oil consumption. It also automatically types a record. It is mainly used by departments of engines, automobiles, tractors, internal combustion vehicles, airplanes, and ship manufacturing to measure machine torque, rotary speed, power, oil consumption time, oil consumption rate, oil consumption weight, etc. A new equipment has thus been added to increase and improve China's mechanized power products. The instrument has been certified for production in batches.

AUTHOR: XU Yu [6079 1342]

ORG: None

TITLE: "Nondispersion Atomic Fluorescence Photometer"

SOURCE: Beijing YIQI YU WEILAI [INSTRUMENTATION AND FUTURE] in Chinese No 12, 81 p 20

ABSTRACT: With the help of such organizations as Chinese Academy of Sciences, Shanghai Research Institute of Metallurgy, etc., Wenzhou Instrument Plant has succeeded in making the WYF-II nondispersion atomic fluorescence photometer. It has a flame atomic fluorescence channel, a flame emission channel, and a hydrogenation atomic fluorescence channel. Its structure is simple. It is broadly applicable for analyzing metallic foreign elements in highly pure material manufacturing industries, geological prospecting, for determining metallic element contents of blood and urine in medicine, and for measuring traces of metallic elements in drinking water, industrial wastewater, the atmosphere, soils, animals, and plants. The instrument is highly sensitive. For many elements, it can measure to a ppb level. It is also easily and conveniently operated and repaired.

AUTHOR: XIE Fugen [6200 4395 2704]

ORG: None

TITLE: "Steel Iron Surface Hardness Grader"

SOURCE: Beijing YIQI YU WEILAI [INSTRUMENTATION AND FUTURE] in Chinese No 12, 81 p 20

ABSTRACT: Through joint research, the Shanghai Materials Research Institute and the Kaifeng Instrument and Meter Plant No 2 have successfully made the noncontact type GCF-1 steel and iron surface hardness grader. Using the electromagnetic induction theory and the method of comparison, it can quickly inspect and grade batches of parts and components according to their surface hardness, the depth of the carburized layer, the depth of the quench hardened layer, the depth of the decarbonized layer, etc. It is equipped with probing heads of many calibers for the choice of the users; therefore, it may be used to test the characteristic of the materials of the surface of parts of all shapes and sizes. Advanced technologies of resonance analysis and phase analysis are adopted to produce a good grading result. With suitable accessories, it can automatically grade large numbers of parts very fast. The instrument has been certified for production by Kaifeng Instrument and Meter Plant No 2.

6248
CSO: 4009/248

AUTHOR: HU Hsun

ORG: U.S. Steel Research Laboratory, Monroeville, PA

TITLE: "Elastic Properties of Cold-rolled and Annealed Sheets of Phosphorus Steel Having High Normal Plastic Anisotropy"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 595-606

TEXT OF ENGLISH ABSTRACT: The elastic properties of cold-rolled and the subsequently annealed sheets of a phosphorus steel having high normal plastic anisotropy and low planar plastic anisotropy have been calculated according to the averaging procedures of Voigt, Reuss and Hill, incorporated with texture-weighting functions. The calculated values of Young's modulus in the various directions lying in the sheet plane were compared with those determined experimentally by ultrasonic measurements. Results indicate that the Hill averages are very close to reality, whereas the Voigt and Reuss averages are somewhat too high and too low, respectively, in comparison with experimentally measured values. This paper has been prepared to help familiarize metallurgists, engineers and students with the mathematical treatments that can be used for such studies. The procedures used for the calculations are described in detail, and examples of calculations are provided in the appendix.

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LIU Jiale [0491 0857 2867]
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ORG: MAN and LIU both of the Institute of Metal Research, Chinese Academy of Sciences; XU of the Shanghai Steam Turbine Manufactory

TITLE: "Corrosion Damage of Some Cast Superalloys Exposed to Burning Natural Gas in Boiler Chamber"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 607-616

TEXT OF ENGLISH ABSTRACT: With the goal of examining the high temperature corrosion damage of seven conventional cast superalloys, the experiments were made of the exposure of representative specimens to burning natural gas in a steam boiler combustion chamber under temperatures between 700-850°C for a long time, up to 13,000 hours. The following observations with specimens have been done: macro- and micro-metallography, weight changes, X-ray diffraction analysis, EPMA, glow discharge emission spectroscopy, etc. The alloy K18 was corroded seriously enough to swell and crack; K3 and K19 appeared with some small protuberances; and the rest suffered slight corrosion. These alloys in order of resistance to corrosion damage seem to be as follows: FSX414, M38, 537, K17G, K3, K19, K18. Their corrosion

[Continuation of JINSHU XUEBAO No 6, Dec 81 pp 607-616]

behaviors are also discussed in detail. The presence of Cr, Ti and Al enriched layers in the oxidizing scale is regarded as an important factor for resistance to high temperature corrosion.

AUTHOR: LIN Dongliang [2651 2767 2733]
WU Jiansheng [0702 1696 3932]
YANG Zhengrui [2799 2973 3843]
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ORG: All of Shanghai Jiaotong University

TITLE: "Morphology of Subcritical Growth on Stress Corrosion Cracking and Plastic Zone at Crack Tip"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 617-624

TEXT OF ENGLISH ABSTRACT: Using polished cantilever specimens made of two high strength steels, 40CrNiMoA and AISI4330M, the nucleation and propagation on stress corrosion cracking in distilled water have been traced by the metallographic shadowing technique. The morphology of subcritical crack growth has also been observed. It was indicated that the shadow zone, i.e., a plastic deformation area in the front of the crack tip, reveals its different morphologies in various steels. In 40CrNiMoA, the shadow zone grows and joins with the crack propagation. In 4330M, they do not joint together but develop along two parallel paths. The earlike shadow zone immediately appearing at the crack tip after loading can be considered as the plastic zone at the crack tip. However, the shadow zone hereafter observed during the whole process of crack propagation seems not to present the

[Continuation of JINSHU XUEBAO No 6, Dec 81 pp 617-624]

plastic zone at the crack, but to represent the deformation induced by the formation of shear lip and can be related closely to the pop-in. This should be distinguished from the plastic zone at the crack tip in the linear elastic fracture mechanics.

AUTHOR: LI Douxing [2621 2435 2502]
YE Hengqiang [5509 1854 1730]

ORG: Both of the Institute of Metal Research, Chinese Academy of Sciences

TITLE: "An Electron Diffraction Analysis of Precipitates in a 13Ni Maraging Steel (280 kgf/mm^2)"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 625-634

TEXT OF ENGLISH ABSTRACT: The precipitates in 13Ni maraging steel (280 kgf/mm^2) have been identified in relation to the orientation of σ and δ phases in martensite matrix by means of X-ray and selected area electron diffraction analyses. It was shown that the precipitates as an intermediate compound of δ-(Fe, Ni, Co)Mo are responsible for strengthening in the steel. In the case of as-forged after aging, the μ-phase appearing may reduce its toughness. After over-aging, e.g., 580°C for 16 h, a.c., some reverted austenite was formed. From observation *in situ* on heating the aged specimen in an electron microscope up to 743°C, the δ grains were coalesced and the needle-like σ-phase precipitated. Though the diffraction patterns of the δ or σ phase can be commonly indexed, the difference of orientation between δ/α and σ/α seems to be more easily used to distinguish them in the maraging steel.

AUTHOR: WU Yunzhong [2976 5686 1813]
SUN Chenglong [1327 2110 7893]

ORG: Both of the Shanghai Institute of Metallurgy, Chinese Academy of Sciences

TITLE: "Activation Energy of Electromigration in Thin Metal Films"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 635-642

TEXT OF ENGLISH ABSTRACT: The accumulation of non-equilibrium defects in thin metal films during electromigration may cause their resistance to increase. The change of the resistivity has been derived as either of the following equations:

$$\frac{d\left(\frac{\Delta R}{R_0}\right)}{dt}=\frac{cmj^2\rho^{1/2}Z_i^*eD_0}{\lambda^{1/2}kT}\exp\left(-\frac{Q}{kT}\right)$$

and

$$\frac{d\left(\frac{\Delta R}{R_0}\right)}{dt}=\frac{c_1mj^2\rho^{1/2}Z_i^*eD_0\sqrt{2(T-T_1)+\alpha(T-T_1)^2}}{\lambda^{1/2}kT}\exp\left(-\frac{Q}{kT}\right)$$

by which the activation energy of electromigration, Q, in the thin metal films is quite easily determined. For example, in the Al-3.2 percent Cu alloy stripe,

[Continuation of JINSHU XUEBAO No 6, Dec 81 pp 635-642]

Q = 0.65 ± 0.04 eV, calculated by the former equation; and in pure Al film, Q agrees with Hummel's result after being treated with his data and calculated by the latter one.

AUTHOR: ZHENG Zhaobo [6774 0340 0514]*

ORG: University of Science and Technology of China

TITLE: "Fuzzy Symmetric Group and Short-range Order in the Structure of Amorphous Solids"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 643-651

TEXT OF ENGLISH ABSTRACT: A concept, fuzzy symmetric group, is introduced and subsequently applied to the description of short-range order in the structure of amorphous solids.

* Recently engaged in advanced studies at the Department of Physics, University of Louisville, Louisville, Kentucky, where the research was carried out.

AUTHOR: LIU Zhengxian [0491 1767 0341]
ZHENG Longru [6774 7893 1172]
CHEN Nianyi [7115 1819 6318]
YAN Licheng [7051 4539 6134]

ORG: LIU, ZHENG and CHEN all of the Shanghai Institute of Metallurgy, Chinese Academy of Sciences; YAN of the Shanghai University of Science and Technology

TITLE: "Multidimensional Bond-parameter Analysis of Oxide Systems"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 652-660

TEXT OF ENGLISH ABSTRACT: The semiempirical rules of the thermodynamical properties of oxide systems have been proposed by the pattern recognition technique with chemical bond-parameter, and an empirical function L has been suggested as a scale for the acidity or basicity of oxides. It seems to indicate that the correlation between L and such physico-chemical quantities as the heat of formation of complex oxides, the heat of mixing of oxide melts, the activity coefficient and polymerization equilibrium $K_{\ell,n}$ of Masson's model of slags may be presented respectively. The applications of the L function are illustrated with some examples.

AUTHOR: XU Chi [1776 7459]

ORG: Shanghai Institute of Metallurgy, Chinese Academy of Sciences

TITLE: "On the Threshold Value ΔK_{th} of Rare Earth-Magnesium Ductile Iron"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 661-666

TEXT OF ENGLISH ABSTRACT: Estimation of threshold value ΔK_{th} in fatigue crack growth of different RE-Mg ductile irons under lower stress revealed that the existence of ΔK_{th} in the irons is affirmed. The ΔK_{th} decreases in value with the increase of either pearlite occurring in matrix or phosphorus content. The processing, such as the metal-backed shell mold casting and gas soft-nitriding, may increase the ΔK_{th} to a certain extent. Under lower fatigue stress, the blunt effect of graphite nodules at the tip of the crack causes the ΔK_{th} value to be greater than that of common structural steel. While the stress approaches the critical value of unstable crack propagation, the stress-concentration effect of graphite nodules decreases the resistance to crack propagation, thus causing its fracture toughness to be lower than that of steel. The σ_{-1} value which represents the energy required for crack initiation is dependent upon the strength of the ductile iron matrix, and the ΔK_{th} value which represents the energy required for crack propagation is dependent upon the toughness of the matrix. The effects of various matrix microstructures on these two values are contrary. A combined consideration of both values should be taken in the selection of materials used.

AUTHOR: ZHONG Xiangchong [6945 7449 1504]
ZHANG Lihua [1728 7787 5478]

ORG: Both of Luoyang Institute of Refractories Research

TITLE: "Microstructure in Fusion-cast Magnesite-chrome Bricks for Use in Copper Flash-smelter"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 667-672

TEXT OF ENGLISH ABSTRACT: The principal mineralogical constituents of fusion-cast magnesite-chrome refractories were identified as periclase solid solution, intergranular spinel and forsterite solid solution. Their amount and composition, crystal size and some of the optical properties are determined and their empirical formulas have been predicted. The characteristics of each type of microstructure observed as well as the conditions of its formation are discussed. Such brick after service in copper flash smelters may be distinguished into slag zone, reaction zone and unaltered zone. It is due to the thin reaction zone and absence of a transition zone that no penetration of low melting phase has substantially occurred. From the results of chemical analysis and petrological observation of various zones it may be concluded that the main attack comes from the ferrous silicates and iron oxide in the slag which corrode the periclase and spinel in the brick, and that the periclase is more easily eroded than intergranular spinel. The basic requirements

[Continuation of JINSHU XUEBAO No 6, Dec 81 pp 667-672]

for the microstructure of the brick for service in the copper flash smelter are discussed and measures for control of the microstructure have been suggested.

AUTHOR: WANG Zhenjie [3769 2182 2638]
PENG Yuqing [1756 6735 0615]
YUAN Heling [5913 7729 7881]
WANG Jingcheng [3769 2529 2052]

ORG: WANG Zhenjie, PENG and YUAN all of the Shanghai Institute of Nuclear Research, Chinese Academy of Sciences; WANG Jingcheng of the Shanghai Institute of Iron and Steel Research

TITLE: "Measurement of Dislocation Densities Using Positron Annihilation"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 673-676

TEXT OF ENGLISH ABSTRACT: The positron annihilation technique is available to measure the dislocation densities of not only pure metals but also high alloys within the range of 10^{12} cm^{-2}.

AUTHOR: JI Guokun [1323 0948 0981]
LIU Nianqing [0491 1628 1987]
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JIANG Jian [1203 0256]
XIONG Liangyue [3574 5328 6885]
LONG Qiwei [7893 2601 1218]

ORG: JI, LIU and WANG all of the Institute of High Energy Physics, Chinese Academy of Sciences; JIANG, XIONG and LONG all of the Institute of Solid State Physics, Chinese Academy of Sciences (now at the Institute of Metal Research, Chinese Academy of Sciences)

TITLE: "An Investigation of the Plastic Zone in the Vicinity of the Crack-tip by Positron Annihilation Technique"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 677-681

TEXT OF ENGLISH ABSTRACT: Central cracked and single edge cracked α-Ti specimens were loaded up to different stress levels and cut into four test pieces after unloading. Both parameters, positron lifetime and Doppler broadening lineshape S, were measured in the plastic zone at the crack-tip. The Doppler broadening lineshape S parameters were measured as a function of distance from the crack-tip along the crack direction. It was found that the S parameters decrease monotonically

[Continuation of JINSHU XUEBAO No 6, Dec 81 pp 677-681]

along the crack direction until the boundary of the plastic zone is reached. The size of the plastic zone estimated by the positron annihilation method seems to agree roughly with that obtained from that calculated by fracture mechanics.

AUTHOR: GE Yunlong [5514 0061 7893]
CHAI Shousen [2693 1108 2773]

ORG: Both of the Institute of Metal Research, Chinese Academy of Sciences

TITLE: "Abnormal Segregation of Mn in an Austenitic High-Mn Steel"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 687-689

TEXT OF ENGLISH ABSTRACT: The abnormal segregation of Mn along grain boundaries in an austenitic steel containing 26 percent Mn was identified by both Auger energy spectrum and ion microprobe analysis. The morphology of its high temperature fractograph is shown as brittle intergranular fracture instead of normal ductile dimple.

AUTHOR: CAO Mingzhou [2580 0682 3166]
ZHAO Jixiang [6392 0679 4382]
SU Ge [5685 7245]
WAN Xiaojing [8001 2556 2589]

ORG: All of the Institute of Metal Research, Chinese Academy of Sciences

TITLE: "On the Steady State Creep of Alloy Ti-679"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 690-694

TEXT OF ENGLISH ABSTRACT: The steady state creep rate of alloy Ti-679 under various temperatures and stresses was examined. A cyclic test on strain rate was also made of its apparent activated area as a function of temperature. Some approaches to the creep mechanism of the alloy are discussed.

AUTHOR: NING Yuantao [1380 6678 3447]

ORG: Institute of Precious Metals

TITLE: "Relationship between Contact Angle for Glass on Pt Alloys and Glass Viscosity"

SOURCE: Shenyang JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese No 6, Dec 81 pp 695-698

TEXT OF ENGLISH ABSTRACT: An expression is proposed for the relationship between the contact angle of glass on Pt or its alloys and glass viscosity, $\theta = p\eta^{q}$, based on the derivation of their temperature dependence, $\log \theta - 1/T$ and $\log \eta - 1/T$. The value p or Q parameter is characterized by the glass-Pt alloy interface energy, as well as the constitution of glass and wetted metal or alloys and interaction between glass and metal. The idea of bond parameters is suggested to correlate with the values of p and q.

9717
CSO: 4009/251

AUTHOR: JIANG Shifei [5592 1102 7378]

ORG: None

TITLE: "The Microprogram and the Distributed System"

SOURCE: Shenyang ZHONGXIAOXING JISUANJI [MINI-MICRO SYSTEMS] in Chinese No 6, 10 Dec 81 pp 1-10

ABSTRACT: This paper makes the point that there is a very close relationship between microprograms and distributed systems. This is manifested in the following facts: (1) There are similarities in their fundamental problems. They can both be analyzed with similar theories, such as the information net theory. (2) They can be mutually developed and their results can be mutually utilized. Data flow distributed systems are based on information net theory proposed by Petri in 1962. Researchers at MIT and the University of Manchester recognize the need to use microprograms to realize these systems. The paper proceeds to explain the basic concepts of information net theory. Any realized system at any specific time must be in a certain state. When certain specified conditions are fulfilled, it will undergo a transformation and achieve a new state. Distributed systems, subsystems, or even microinstructions can all be described in terms of states S and transformations T. Numerous diagrams are provided which illustrate various transformations of state. The applicability of information net theory to program design is

[continuation of ZHONGXIAOXING JISUANJI No 6, 1981 pp 1-10]

discussed. This is illustrated with a discussion of the microprogram used to implement IBM 370 RX format instructions. The paper concludes that information nets can exercise a very long asynchronous control function. It makes the point that such a net theory can not only be used to design computers, data communications, distributed systems and microprograms, but also total systems, subsystems, computer instructions, and micro instructions.

AUTHOR: ZHU Yixin [6175 0034 2450]

ORG: The 631 Research Institute, The Third Ministry of Machine Industry

TITLE: "The Organization of an Airborne Fault-Tolerant Multiprocessor System"

SOURCE: Shenyang ZHONGXIAOXING JISUANJI [MINI-MICRO SYSTEMS] in Chinese No 6, 10 Dec 81 pp 25-33, 10

ABSTRACT: In recent years, in considering the requirements of airborne distributed processing systems, high reliability has been sought through redundancy and fault-tolerant technology. Fault-tolerant computers have been systematically studied, including such as STAR, UDS, etc. Software has been adopted as the main basis of fault-tolerance. After studying the characteristics of 8 and 16 bit processors, the Z-80 has been adopted as the I/O processing unit and the Z 8000 has been adopted as the main processing unit. The American military standards (AIRCRAFT INTERNAL TIME DIVISION COMMAND/RESPONSE MULTIPLEX DATA BUS) MIL-STD-1553A and 1553B were studied and the 1553B was adopted. The paper proceeds to diagram the structure of the proposed system which is explained at some length. In explaining the principles of fault tolerance, the paper makes the point that software and hardware are used to mutually isolate faults, and software is used to identify faulty components. Numerous details of construction are given, such as the number of components on various boards, the adoption of the Zilog ZBI Bus, etc. Computations are made regarding such things as mean time between failures. A formula for the overall

[continuation of ZHONGXIAOXING JISUANJI No 6, 1981 pp 25-33, 10]

failure rate of the system is provided and a final result is listed as 2.65×10^{-8}/hour, which, the paper concludes, meets the requirements of reliability for aircraft control system computers. When microcomputers are used as the heart of a distributed system, the star form (shaped) multiprocessor system, the paper maintains, facilitates the expansion and contraction of the system to make it suitable for many airborne applications. Software is the basis of the fault tolerance. No special hardware was designed, therefore.

6168
CSO: 4009/240

AUTHOR: LEI Qianrong [7191 6197 2837]

ORG: None

TITLE: "Preliminary Analysis of Underground Construction Engineering Geology of Chongqing City"

SOURCE: Chongqing DIXIA GONGCHENG [UNDERGOUND ENGINEERING] in Chinese No 12, 11 Dec 81 pp 22-28

ABSTRACT: Being an industrial city of dense population and relatively serious environmental pollution problems, Chongqing's direction of development has naturally been under the ground. Its mountainous location with a range of grade differential of 20-90 m also provides advantages for underground construction. Based upon the experience in underground construction of a section of that city (map included) measuring about 250 km^2, this paper reviews the considerations for the rock formation, geological structure, weathering action, ground water, and engineering aplications of that section for the purpose of providing references for future underground development of other sections of the city, areas of Central Sichuan, and regions of similar geological conditions. Problems of regional stability, protection and reinforcement of underground structures, etc. are analyzed. The rock bodies of the section are classified into 4 types and several subtypes and described. In view of the fact that engineering properties of these rocks vary a great deal from area to area within the section, concretion evaluation is required for every area. Measures for protection and reinforcement adopted for such structures as the south tunnel of the Changjiang Bridge and the 15 m span cavern of the Sichuan Shipbuilding Plant are judged to be adequate and satisfactory and it is believed that shotcrete anchorage technology will be extensively adopted in the city in the future.

AUTHOR: None

ORG: None

TITLE: "Shotcrete Anchorage Conference Held in Anhui"

SOURCE: Chongqing DIXIA GONGCHENG [UNDERGROUND ENGINEERING] in Chinese No 12, 11 Dec 81 back cover, p 73

ABSTRACT: The China Metal Society Shotcrete Anchorage Technology Conference was held on 21-27 Oct 81 in Tongling City of Anhui Province. It was jointly sponsored by the Mining Technology Committee and the Construction Technology Committee of China Metal Society. Participants included 135 specialists representing Departments of Metallurgy, Railway, Coal, Hydroelectricity, Chinese Academy of Sciences, Chinese People's Liberation Army Corps of Engineers, etc. Copies of abstracts of the 60 papers to be delivered were distributed before the opening. During the meetings, such important problems as mechanism and design of shotcrete anchorage, shotcrete anchorage technology for weak and clastic rock bodies, and environmental protection, tools and equipment, materials, and quality control of shotcrete anchorage technology are exchanged and discussed. The delegates visited the tunnel of the Wan [Anhui]-Gan [Jiangxi] Railway.

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March 9, 1982